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Diversity, phytogeographical distribution, endemism and conservation status of Zingiberaceae in India

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Abstract

Monocotyledonous angiosperm family Zingiberaceae (Ginger family) is one of the most economically important and treasured monocotyledonous families. The members of this family consist of a large number of medicinal plants and they are also well known for their use as spices and condiments. The family is represented by 53 genera and about 1377 species distributed worldwide. Malaysian regions (Indonesia, Malaysia, Singapore, Brunei, Philippines and Papua New Guinea) have the highest diversity in the family. In India, it is represented by about 230 species and eight varieties falling under 22 genera. The largest genera are *Hedychium,* with 43 species, followed by *Zingiber* with 41 species, *Curcuma,* with 38 species and *Globba* and *Amomum,* with 20 and 19 species respectively. Two monotypic genera, *Parakaempferia* and *Stadiochilus* are found in India of which *Parakaempferia* and about 102 species are endemic to India. Some of the endemic species are categorized as rare, threatened and endangered as per IUCN Red List Categories and Criteria. In this study, the genus-wise representation of species with a position of endemism in India (based on literature) and other geographical analyses were done.

Keywords

Zingiberaceae; phytogeography; endemism; RET taxa

Introduction

Zingiberaceae, most commonly known as the ginger family, is one of the valuable and interesting groups of monocots. It is represented by 53 genera and about 1377 species globally (1). At present, the family consists of 54 genera and about 2050 accepted species. The genus *Adelmeria* Ridl. was reinstated, which is endemic to the Philippines based on molecular and morphological evidence (2). The genus was formerly treated entirely as a synonym of *Alpinia*. However, many new species and genera have been discovered recently and therefore, the total number of genera and species is very uncertain. The first classification of the family was given by Petersen and recognized 3 tribes Hedychieae, Globbeae, Zingibereae (3). A recent classification has been proposed based on DNA sequences of the nuclear internal transcribed spacer (Ribosomal region) and chloroplast mark regions that recognize 4 subfamilies and 4 tribes (4): Siphonochiloideae (Siphonochileae), Tamijioideae (Tamijieae), Alpinioideae (Alpinieae, Riedelieae) and Zingiberoideae (Zingibereae, Globbeae). Among the 4 subfamilies, Zingiberoideae and Alpinioideae are represented in India.

The Zingiberaceae family is well-represented in India, with 22 genera and 178 species, primarily concentrated in the north-eastern and peninsular regions of the country (5). In a recent research article, it is mentioned that the family in India is represented by 20 genera and about 215 species (6). However, in their research article, they did not mention the origin of the data. In the present investigation, it was noticed that the number of genera has increased to 22 and 238 species (Table 1). Six genera previously synonymized with *Amomum*, *i.e.*, into 6 genera: *Conamomum*, *Epiamomum*, *Lanxangia*, *Meistera*, *Sundamomum* and *Wurfbainia* were resurrected (7), and among these 6 genera, 2 namely *Meistera* and *Wurfbainia* are found in India. Recently, the monotypic ginger genus *Stadiochilus* R. M. Sm. has been reported from Nagaland, India (8), which has only been known from Myanmar. Many botanists have done notable work to study several genera in India e.g. *Hedychium* (9, 10), *Alpinia* (11), *Curcuma* (12-14), *Cautleya* (15), *Roscoea* (16), *Amomum* (17), *Zingiber* (18, 19), *Larsenianthus* (20) or study of the family for a particular geographical area (21-26). Although all these mentioned works have been done for a particular state of India except for some researchers who covered the genus *Caulokaempferia* (27) and studied *Cautleya* in India (28). A complete revisionary work of *Gagnepainia* and *Hemiorchis* has was done throughout their distributional ranges (29). The only comprehensive account in India was done on the gingers of South India and published as "Zingiberaceae and Costaceae of South India" (26).

Among all these Indian genera and species, one genus (*Parakaempferia*) and about 102 species are endemic to India. Attempt was made to record the phytogeography and endemism of Indian Zingiberaceae (5). They listed all species with tabulation with their distribution in states. It appears more than 25 years after this detailed list of Indian Zingiberaceae.

Materials and Methods

The list prepared (5) is the precursor of our study, where they recorded Indian Zingiberaceae species and their distribution in states. The study aims to furnish a thoroughly annotated checklist detailing the Zingiberaceae family in India. We subdivided India using the third-level areas in the International Working Group on Taxonomic Databases (TDWG) standard world geographical scheme for recording plant distributions. In India these are Indian Subcontinent-Assam (Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura), East Himalaya (Arunachal Pradesh, Darjeeling, Sikkim), India (26 areas), West Himalaya (Himachal Pradesh, Jammu-Kashmir, Uttaranchal), Andaman and Nicobar Islands. To make our study easier, we have categorized geographical regions into 6 categories, viz. Northeast India (6 states, excluding Sikkim), South India (4 states) Maharashtra, Andaman Islands, West Himalaya and East Himalaya (excluding Arunachal Pradesh), and other countries.

The International Plant Names Index (IPNI) and other available publications on Zingiberaceae were searched for names, distribution and endemic species that are found in India (37). After a critical literature scrutiny and herbarium consultation, a comprehensive list of the family has been prepared. Distributions of some of the species are not complete because this work is based on previous specimen data. Although the distribution of many species is complete, there is no conflict because those species are found in limited geographical regions of India. Endemism is deemed a substantial factor for biodiversity conservation at the global level and identifying the number and distribution of endemic plants in a biogeographic area is a preliminary point for evaluating the protection of that defined region.

Southeast Asia is recognized as the center of distribution of Zingiberaceae. So far, the greatest concentration

Table 1. Overview of genera of Zingiberaceae in India with the number of species in India, number of endemic species [in brackets], approximate number worldwide

Sl. No.	Genera in India	Number of species (India)	Approximate number of species (Worldwide)
1	*Alpinia* Roxb.	16 [2]	230 (30)
2	*Amomum* Roxb.	18 species and 1 variety [12]	150 (31)
3	*Boesenbergia* Kuntze	11 [4]	80 (32)
4	*Caulokaempferia* K. Larsen	5 [2]	30 (27)
5	*Cautleya* (Royle ex Benth.) Hook.f.	2 species and 2 varieties	4 (28)
6	*Curcuma* L.	38 [18]	120 (33)
7	*Elettaria* Maton	1	2 (34)
8	*Etlingera* Giseke	3 [2]	100 (35)
9	*Globba* L.	19 species and 1 variety [6]	121 (36)
10	*Hedychium* J. Koenig	41 species and 2 varieties [20]	80 (37)
11	*Hemiorchis* Kurz	2	3 (29)
12	*Hornstedtia* Retz.	2 [1]	40 (38)
13	*Kaempferia* L.	5 [1]	50 (39)
14	*Larsenianthus* W. J. Kress & Mood	3 species and 1 variety [3]	5 (20)
15	*Meistera* Giseke	11 [6]	42 species 3 varieties (7)

16	*Parakaempferia* A. S. Rao & D. M. Verma	1 [1]	1 (40)
17	*Plagiostachys* Ridl.	1 [1]	18 species (39)
18	*Rhynchanthus* Hook. f.	1	6 (41)
19	*Roscoea* Sm.	7 [1]	21 (42)
20	*Stadiochilus* R. M. Sm.	1	1 (8)
21	*Wurfbainia* Giseke	1	27 species and 2 varieties (7)
22	*Zingiber* Mill.	41 species 1 variety [22]	150 (39)

of genera and species is in Malaysia, Indonesia, Papua, Brunei, Singapore, Thailand and the Philippines. In India, the members of the family are mainly found to occur in Southwest India especially the Western part of the peninsula and Northeast India. Phytogeographic distributions of all species that are found to occur in India are listed in supplementary data (Supplementary Table). The following account deals with each representative genus occurring in India.

Results and Discussion

1. *Alpinia* Roxb.

This is the largest genus of Zingiberaceae, with over 230 species. In India, 16 species are found. *Alpinia manii* is endemic to Andaman and Nicobar Islands and *Alpinia smithiae* is endemic to Kerala.

A. galanga and *A. calcarata* are cultivated for ethnomedicinal use. *A. galanga* has various benefits, from being used as a food flavoring to treating for multiple diseases like breathing, stomach diseases, diarrhoea and stomach cramps (43). The rhizome extract of *A. calcarata* is used as an expectorant in the treatment of bronchitis and asthma for purifying blood, stimulating digestion and improving voice (44).

2. *Amomum* Roxb.

This is the second largest genus after *Alpinia* Roxb. in the family, having around 150 species distributed mainly in SE Asia. In India, the genus is represented by 18 species and one variety is mainly concentrated in northeast India. Among 19 species of the genus, 12 are endemic to India.

3. *Boesenbergia* Kuntze

The genus is represented by 11 species in India, 4 of which are found exclusively in Northeast state and Andaman Island. *B.albolutea* and *B. rubrolutea* are endemic to Andaman and Meghalaya, but there has been no report of these 2 species after the type collection and therefore, the recently recommended IUCN status for these 2 species is extinct in the wild (45).

B. rotunda, commonly known as finger root, is a daily food ingredient and traditional medicinal plant in Southeast Asia and Indo-China.

4. *Caulokaempferia* K. Larsen

Four species of the genus are recognized in India. *C. arunachalensis* and *C. suksathanii* are endemic to Arunachal and Manipur respectively. The genus showed the highest diversity in Thailand.

5. *Cautleya* (Royle ex Benth.) Hook.f.

Cautleya is a small genus of 4 species with thick root fibers. In India, the genus is represented by 4 species distributed in the North-eastern states, Himachal Pradesh and West Bengal. Species of the genus grow sufficiently in their natural habitat. The taxa are considered Least Concern (LC) according to IUCN Red List Categories.

6. *Curcuma* L.

The genus *Curcuma* is of great economic importance, with around 120 species. To date, 38 species have been reported in India, among which 18 taxa are endemic. The most important species of the genus *C. longa,* which yields turmeric is termed "Oushadhi," a healing herb in Ayurveda. Other than *C. longa,* many other economically important species, such as *C. aromatica*, *C. amada*, *C. caesia*, *C. aeruginosa* and *C. zanthorrhiza* are widely cultivated in India.

7. *Elettaria* Maton

The only species *E. cardamomum*, commonly known as green or true cardamon is native to India. Many cultivars *viz.,* Njallani, Green-bold, Palakkudi, Veeraputhara, Vazhuka are widely cultivated in south India. Among all these cultivar verities of cardamom Vazhuka, bearing purely white flowers, was developed by a farmer from Idukki district, Kerala and has the highest yielding capacity.

8. *Etlingera* Giseke

The genus is represented by 3 species in India distributed in Northeast India and the Andaman Islands. Two species are endemic, *viz*. *E. fenzlii* in Andaman Island and *E. loroglossa* in Assam and Meghalaya.

9. *Globba* L.

Globba L. is the third largest genus of the Zingiberaceae, with about 121 species distributed throughout tropical and parts of subtropical Asia, ranging from India to southern China and south and east to the Philippines and New Guinea. In India, the genus is represented by 19 species and 1 variety, of which 6 taxa are endemic. *Globba radicalis*, *G. wardii* and *G. wengeri* have been listed in the IUCN Red List of Threatened Species due to their extreme rarity and small population in their natural habitat.

10. *Hedychium* J.Koenig

Hedychium is commonly known as "ginger lily" or "butterfly lily" due to the similarity of their labellum and lateral staminodes with that of the wings of the butterflies. The genus comprises of about 80 species, distributed from India to South East Asia (37). In India, it is the most diverse and largest genus of Zingiberaceae and is represented by

43 taxa (41 species and 2 varieties), mostly restricted to Northeastern India. Among 43 taxa of Indian *Hedychium*, 20 taxa are endemic, of which 18 taxa are reported from northeast India and the remaining 2 are from South India. *H. aureum* has most recently been assessed for IUCN Red List of Threatened Species in 2018.

11. *Hemiorchis* Kurz

The genus comprises of 3 species globally and 2 taxa are found in India. None of them are endemic.

12. *Hornstedtia* Retz.

Two species viz. *H. arunachalensis* and *H. costata* occur in Assam and Arunachal Pradesh and the former is endemic to northeast India.

13. *Kaempferia* L.

This medicinally important and medium-sized genus comprises approximately 60 species around the world and 5 species occur in India. Only one taxa viz. *K. evansii* is endemic to south India. Rhizomes of *K. parviflora* are in high demand for its medicinal use.

14. *Larsenianthus* W.J.Kress & Mood

The new Asia genus *Larsenianthus* consists of 4 species and 1 variety distributed in Myanmar, Sub-Himalayan forests in North-Eastern Bangladesh, the Indian States of Meghalaya, Assam, Arunachal Pradesh, Manipur. In India, 4 taxa are reported from northeast India and among the reported taxa 2 species and the only variety are endemic to India, *viz*. *L. arunachalensis*, *L. arunachalensis* var. *reticulatus* and *L. assamensis*. Due to the anthropogenic activities, these 3 taxa are in the category of Near Threatened (NT) under IUCN guidelines (20).

15. *Meistera* Giseke

The genus includes species formerly placed in the genus *Amomum*. Certain species of *Amomum* are transferred to the genus *Meistera* based on morphological character and phylogenetic analyses (7). The genus has 42 species and 3 varieties distributed from Sri Lanka and India throughout the Indochinese region to Sundaland. Currently, 11 species are reported from India among which 6 taxa are endemic to India.

16. *Parakaempferia* A.S.Rao&D.M.Verma

Parakaempferia, is a monotypic genus, its only species *P. synantha,* is reported from the Northern states of India *viz.* Assam, Arunachal Pradesh and Mizoram.

17. *Plagiostachys* Ridl.

In India the genus is represented by only 1 genus *P. nicobarica* that is endemic to Nicobar Island, India.

18. *Rhynchanthus* Hook.f.

The genus is represented by 4 species distributed in India, China, Bangladesh, Myanmar and Thailand. In India, only 1 species, *viz*. *R. longiflorus* is reported from Mizoram. This species, commonly known as the East Indian Beak flower, is characterized by beautiful decorative showy inflorescence. Due to anthropogenic intervention, the natural habitat of the taxa is degrading. Therefore, proper and adequate information is essential for the conservation and preservation of this species (46).

19. *Roscoea* Sm.

The genus *Roscoea* J. E. Smith is represented by 21 species in the world (42). It occurs along the Himalayas from the west (Kashmir) to the east (south-western China), between 1200 and 4880 m (47). In India, the genus is represented by 7 species, one of which 1 is endemic *R. ngainoi* A. A. Mao & Bhaumik.

20. *Stadiochilus* R. M. Sm.

This monotypic genus has only one species, *S. burmanicus* R. M. Sm., was earlier known from Myanmar. Recently, the species was reported from Nagaland, India and for conservation purposes, this species was evaluated according to the IUCN Red List Categories and Criteria and assessed as endangered (8).

21. *Wurfbainia* Giseke

Wurfbainia, with 27 species and 2 varieties, is the most diverse in the Indo-Chinese floristic region. In India, the genus is represented by a single species. *W. aromatica* is of much economic importance as it is used traditionally to treat dyspepsia, flatulence, colic, vomiting, diarrhoea and cough, chronic malaria (48).

22. *Zingiber* Mill.

The genus has about 150 species distributed all over the world. In India, it is represented by 42 taxa, of which 22 species are endemic to India. Northeast India has the highest diversity of the genus, with 30 taxa known from these regions. About 60% of Indian Zingiber is found in this area. It is one of the most economically important genera of the family for their medicinal and ethno-medicinal uses. *Z. officinale* is widely cultivated throughout the world.

Endemism and RET taxa

India boasts a significant presence of the Zingiberaceae family, with 22 out of the 54 genera found globally. This constitutes approximately 40% of the total genera found worldwide in this plant family. India exhibits a robust representation of the Zingiberoidea with 14 genera and about 180 species. The remaining 8 genera include the subfamily Alpinioideae, with about 59 species. *Hedychium* is the largest genus with 41 species and 2 varieties. Two monotypic genera, i.e., *Parakaempferia* and *Stadiochilus* are reported from India, and the former is endemic to India (8, 40).

The term "endemic" is used to describe any biological group that is limited in its geographic distribution. These endemics are typically classified into 4 different spatial contexts: a specific location or limited area, a particular habitat, a specific biogeographical region, or a political jurisdiction. Due to their limited range, endemic species are given top priority in conservation efforts. Endemism is a crucial criterion when considering the conservation of any given area. It is seen that 102 taxa out of 238 occurring in India are endemic. It can be said that about 45% of the species are endemic. The genus *Hedychium* and *Zingiber* both have the highest number of endemic species. Species of the following genera show a 50% or more rate of endemism:

Amomum (14/19), *Curcuma* (18/38), *Hedychium* (20/43), *Hornstedtia* (1/2), *Larsenianthus* (3/4), *Meistera* (6/11), *Parakaempferia* (1/1), *Zingiber* (22/42). The genera *Cautleya*, *Hemiorchis, Rhynchanthus* and *Wurfbainia* have no endemic species in India.

Conservation of 'RET' taxa

Despite the invaluable contributions of plants to humanity, their existence is under relentless threat due to ongoing development projects and our growing reliance on them. While numerous species face endangerment due to human activities, others confront the challenges posed by invasive species and the effects of climate change. Consequently, a substantial number of plant species are on the brink of extinction, warranting their inclusion in the International Union for Conservation of Nature's Red List of Threatened Species (RET). IUCN has enlisted more than 8000 plants till 2004 and the number has been increasing day by day. Hence, the conservation of plant species classified as Rare, Endangered and Threatened (RET) has emerged as a matter of utmost significance. Numerous strategies have been implemented by government bodies and various organizations to safeguard these species. The conservation of RET plants primarily relies on *ex-situ* and *in-situ* approaches. However, it is important to recognize that each method comes with its own set of limitations and that conservation strategies must be tailored to the specific needs of plants within the threatened category. Botanical gardens and seed banks play a pivotal role in this critical conservation effort. The concept of resurrection of 'extinct in the wild' species is a captivating and formidable challenge that intrigues both scientists and the general public. While there has been some theoretical advancement in the realm of de-extinct animals, the prospect of resurrecting extinct plants has only recently emerged as a topic of discussion. In plants, this could be achieved by germinating or *in vitro* tissue-culturing old diaspores, such as seeds or spores available in herbarium specimens (49). However, there are dozens of limitations in the de-extinction process, such as the availability of genetic materials, incomplete genetic information, ethical and moral concerns etc. Despite these limitations, the field of de-extinction continues to advance and researchers are actively working to address these challenges. The following threatened plants with dwindling populations need to be critically evaluated and conservation strategies should be adopted (50) (Table 2). Moreover, documenting the plant diversity and identifying the hotspots of different species will help in the assessment and implementation of appropriate conservation plans.

Table 2. Threatened species of Zingiberaceae in India

Species	Status	Distribution
Boesenbergia albolutea (Baker) Schltr.	Extinct in the wild	Andaman
Boesenbergia rubrolutea (Baker) Kuntze	Extinct in the wild	Meghalaya
Globba radicalis Roxb.	Threatened	India (MG,MZ), Myanmar
Globba wardii (B.L.Burtt & R.M. Sm.) K.J. Williams	Near Threatened	India (MZ), Myanmar
Hedychium aureum C.B. Clarke & H. Mann ex Baker	Endangered	India (MG), Bangladesh, Thailand
Larsenianthus arunachalensis M. Sabu, Sanoj & Rajesh Kumar	Critically Endangered	Arunachal Pradesh
Parakaempferia synantha A. S. Rao & D. M. Verma	Critically Endangered	Arunachal Pradesh, Assam, Mizoram
Plagiostachys nicobarica M. Sabu, Sanoj & Prasanthk.	Endangered	Andaman & Nicobar Island
Zingiber arunachalensis A.Joe, T.Jayakr., Hareesh & M.Sabu	Critically Endangered	Arunachal Pradesh

Conclusion

This study relies entirely on pre-existing data sources, such as protologues, monographs and revisions. As a result, the precise number of Zingiber species in India remains uncertain due to the absence of comprehensive taxonomic research. To address this uncertainty, additional field expeditions and meticulous, systematic investigations are imperative. Furthermore, numerous species are teetering on the brink of extinction due to the disruptions caused by various human activities. Among these detrimental actions, urban development stands out as a major driver of habitat loss, resulting in the eradication of a significant portion of native species and posing a risk to other local ecosystems. Additionally, it is worth noting that the IUCN Red List, a widely referenced source for assessing species' conservation statuses, may not always be up-to-date. This raises concerns because many species are currently at risk of extinction and the list may not fully reflect their current status and the urgency of conservation efforts required. For instance, *Rhynchanthus longiflorus* Hook.f., ginger with beautiful decorative inflorescence, is mentioned as rare and endangered and is on the verge of extinction (5). This species was found in a very small population in a hill station of Mizoram called Saireptlang, Lunglei district. Unfortunately, the population of this species is steadily dwindling due to various human activities and interventions. However, the absence of comprehensive and adequate information about this taxon may be a significant factor preventing its inclusion in the IUCN Red List category, underscoring the critical need for detailed research and data to facilitate its conservation (48). As a result, it is imperative to gather accurate and comprehensive information about the members of this family to enable the effective conservation of those facing imminent threats.

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Authors contributions

SD and DV designed the concept of the study. SD performed the data compilation and drafted the manuscript. DV helped in correction and coordination. Both authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interests to declare.

Ethical issues: None.

Supplementary data

Supplementary table : Distribution of the family Zingiberaceae in India

References

1. Kong JJ, Xia YM, Li QJ. Inflorescence and flower development in Hedychieae (Zingiberaceae): *Hedychium coccineum* Smith. Protoplasma. 2010;247:83-90. https://doi.org/10.1007/s00709-010-0145-5
2. Docot RVA, Banag CI, Poulsen AD. Reinstatement and revision of the genus *Adelmeria* (Zingiberaceae) endemic to the Philippines. Taxon. 2019;68:499-521. https://doi.org/10.1002/tax.12071
3. Petersen OG. Musaceae, Zingiberaceae, Cannaceae, Marantaceae. In: Engler A. & Prantl K. (eds.) *Die natürlichen Pflanzenfamilien*. Vol. 2. Leipzig: Wilhelm Engelmann.1889;p.1-43.
4. Kress JW, Prince LM, Williams KJ. The phylogeny and a new classification of the gingers (Zingiberaceae): Evidence from molecular data. American Journal of Botany. 2002;89:1682-96. https://doi.org/10.3732/ajb.89.10.1682
5. Jain SK, Prakash V. Zingiberaceae in India: Phytogeography and endemism. Rheedea. 1995;5:154-69.
6. Kumar R, Singh SK, Sharma S, Mao AA. New and noteworthy records of Gingers from North-east India. Keanean Journal of Science. 2013;2:13-18.
7. de Boer H, Newman M, Poulsen AD, Droop AJ, Fér T, Hiền LTT, Hlavatá K, Lamxay V, Richardson JE, Steffen K, Leong-Škorničková J. Convergent morphology in Alpinieae (Zingiberaceae): Recircumscribing *Amomum* as a monophyletic genus. Taxon. 2018;67(1):6-36. https://doi.org/10.12705/671.2
8. Roy DK, Lytan R, Biate DL, Odyuo N. Stadiochilus R. M. Sm. (Zingiberaceae: Zingibereae), a new generic record for India. Turczaninowia. 2021;24(4):47-53. https://doi.org/10.14258/turczaninowia.24.4.4
9. Srivastava SC. A taxonomic study of genus *Hedychium* Koen. (Zingiberaceae) in India and its vicinity. [Ph.D. thesis]. Kolkata: Calcutta University; 1984.
10. Sanoj E. Taxonomic revision of the genus *Hedychium* J. Koenig (Zingiberaceae) in India [Ph. D thesis]. Kerala: University of Calicut; 2011.
11. Mangaly JK, Sabu M. A taxonomic revision of south Indian *Alpinia* Roxb. (Zingiberaceae). Rheedea. 1992;2:38-51.
12. Kumar S. Turmeric (*Curcuma longa* L.) and related taxa in Sikkim Himalaya. Journal of Economic and Taxonomic Botany. 1991;15:721-24.
13. Mangaly JK, Sabu M. A taxonomic revision of the South Indian species of *Curcuma* Linn. (Zingiberaceae). Rheedea. 1993;3:139-71.
14. Velayudhan KC, Amalraj VA, Muralidharan VK. The conspectus of the genus *Curcuma* in India. Journal of Economic and Taxonomic Botany. 1996;20:375-82.
15. Kumar S. The genus *Cautleya* Royle (Zingiberaceae) in India. Journal of Indian Botanical Society. 1994;73:195-97.
16. Kumar S. The genus *Roscoea* Smith (Zingiberaceae) in India. Higher Plants of Indian Subcontinent.1993;4:11-16.
17. Kumar S, Raju DCS. Large cardamom and its wild relatives in Sikkim Himalayas. Journal of Hill Research. 1989;2:102-07.
18. Kumar S, Raju DCS. Ginger and its allies in Sikkim Himalaya. Higher Plants of Indian subcontinent. 1991;2:249-55.
19. Sabu M. Revision of the genus *Zingiber* in South India. Folia Malaysiana. 2003;4:25-52.
20. Mibang T, Das AK. Taxonomic investigation on genus *Larsenianthus* (Zingiberaceae) of Siang valley, Arunachal Pradesh. Bulletin of Arunachal Forest Research. 2017;32(1&2):41-48.
21. Rao AS, Verma DM. Materials towards a monocot flora of Assam-II. (Zingiberaceae and Marantaceae). Bulletin of Botanical Survey of India. 1972;14:114-43.
22. Bhat KG. Studies on zingiberaceae of Karnataka – A new species and a new record for India. Indian Journal of Forestry. 1988;11:322-26.
23. Bhat KG. Studies on zingiberaceae of Karnataka. Higher Plants of Indian Subcontinent (Add. Ser. IndianJ. For.). 1993;4:39-102.
24. Kumar S. Zingiberaceae. In: Hajra PK, Verma DM, Bandyopadhaya S (eds). Flora of Sikkim. Vol. 1. Calcutta: Botanical Survey of India. 1996; p. 120-34.
25. Kumar S. Zingiberaceae of Sikkim. New Delhi: Deep Publications. 2001;p. 1-83.
26. Sabu M. Zingiberaceae and Costaceae of South India. Calicut University, India: Indian Association for AngiospermTaxonomy. 2006; p. 1-282.
27. Roy DK, Barbhuiya HA. Taxonomy of *Caulokaempferia* (Zingiberaceae) in India. NeBIO. 2013;4(6):1-6.
28. Aishwarya K, Sabu M. Taxonomic revision of the genus *Cautleya* (Zingiberaceae) in India with a description of a new variety. Taiwania. 2021;66(1):79-88. https://doi.org/10.6165/tai.2021.66.79
29. Tan S, Hollands R, Pavlíková M, Fér T, Newman MF. A Revision of *Gagnepainia* and *Hemiorchis* (Globbeae: Zingiberaceae). Edinburgh Journal of Botany. 2020;77(3):455-90. https://doi.org/10.1017/S0960428620000116
30. Kress JW, Liu AZ, Newman M, Li QJ. The molecular phylogeny of *Alpinia* (Zingiberaceae): A complex and polyphyletic genus of gingers. American Journal of Botany. 2005;92:167-78. https://doi.org/10.3732/ajb.92.1.167
31. Mabberley DJ. Mabberley's plant-book: A portable dictionary of plants, their classifications and uses. ed. 3. Cambridge (U.K.): Cambridge University Press; 2008.
32. Aishwarya K, Vinitha MR, Thomas G, Sabu, M. A new species of *Boesenbergia* and rediscovery of *B. rotunda* (Zingiberaceae) from India. Phytotaxa. 2015;197(3):186-96. https://doi.org/.11646/phytotaxa.197.3.2
33. Leong-Škorničková J, Šída O, Jarolímová V, Sabu M., Suda, J. Chromosome numbers and genome size variation in Indian

species of *Curcuma* (Zingiberaceae). Annals of Botany. 2007;100:505-26. https://doi.org/10.1093/aob/mcm144

34. The International Plant Names Index. Published on the Internet http://www.ipni.org/ [accessed March 2023].

35. Poulsen AD. Etlingera of Borneo. Borneo: Natural History Publications; 2006.

36. Sangvirotjanapat S, Đăng TH, Newman MF. Ten new species of *Globba* section *Globba* from continental South-East Asia. Thai Forest Bulletin of Botany. 2020;48(2):212-33. https://doi.org/10.20531/tfb.2020.48.2.15

37. Sirirugsa P, Larsen K. The genus *Hedychium* (Zingiberaceae) in Thailand. Nordic Journal of Botany. 1995;15(3):301-04. https://doi.org/10.1111/j.1756-1051.1995.tb00156.x

38. Docot RVA, Pranada MAK, Mendez NP. A new species of *Hornstedtia* and a new species record of *Globba* (Zingiberaceae) from Palawan, Philippines. Gardens' Bulletin Singapore. 2021;73 (2):413-23. https://doi.org/10.26492/gbs71(2).2019-13

39. Wu TL, Larsen K. Zingiberaceae. In: Wu ZY, Raven PH, Hong DY (eds). Flora of China. Vol.24. Beijing: Science Press & St. Louis: Missouri Botanical Garden Press. 2000; p. 322-77.

40. Rao AS, Verma DM. *Parakaempferia synantha* (Zingiberaceae) – A new genus and species from Assam. Bulletin of the Botanical Survey of India. 1969;29:206-08.

41. Larsen K, Lock JM, Mass H, Maas PJM. Zingiberaceae. In: Kubitzki K (ed). The families and genera of vascular plants. Vol. 4. Berlin: Springer. 1998; p. 474-95. https://doi.org/10.1007/978-3-662-03531-3_49

42. Yoshida T, Yangzom R, Newman MF. *Roscoeame galantha* (Zingiberaceae): A new species from Eastern Bhutan and India. Edinburgh Journal of Botany. 2017;74(3):1-9. https://doi.org/10.1017/S0960428617000142

43. Khairullah AR, Solikhah TI, Ansori ANM, Fadholly A, Ramandinianto SC, Ansharieta R *et al*. A review of an important medicinal plant: *Alpinia galanga* (L.) willd. Systematic Reviews in Pharmacy. 2020;11(10):387-95. https://doi.org/10.31838/srp.2020.10.62

44. Kirtikar KE, Basu BD. Indian medicinal plant. M/s. Bishen Singh Mahendra Pal Singh, New Dehi.Vol. 4. 2nd ed.1935; p. 16.

45. Aishwarya K, Sabu M. On the IUCN status of *Boesenbergia albolutea* and *B. rubrolutea* (Zingiberaceae) and typification of *B. rubrolutea.* Journal of Threatened Taxa. 2021;13(13):20133-35. https://doi.org/10.11609/jott.6707.13.13.20133-20135

46. Prasanthkumar MG, Skornickova J, Sabu M, Jayasree S. Conservation priority and phytogeographical significance of *Rhynchanthus longiflorus* Hook. f. (Zingiberaceae): A rare, endangered species from Mizo Hills, NE India. Current Science. 2005;88(6):977-80.

47. Cowley EJ. A revision of *Roscoea* (Zingiberaceae). Kew Bulletin. 1982;36(4):747-77. https://doi.org/10.2307/4117918

48. Lim TK. *Amomum aromaticum*. In: Edible medicinal and non-medicinal plants. Springer, Dordrecht. 2013; Vol. 5:793-96 p. https://doi.org/10.1007/978-94-007-5653-3_45

49. Rocchetti A, Carta G, Mondoni A, Godefroid S, Davis CC, Caneva G *et al*. Selecting the best candidates for resurrecting extinct-in-the-wild plants from herbaria. Nat Plants. 2022;8:1385-93. https://doi.org/10.1038/s41477-022-01296-7

50. The International Union for Conservation of Nature Red List of Threatened Species. Published on the Internet Version 2022-23. https://www.iucnredlist.org/. Accessed on [accessed March 2023].